

Weltdatenbank Abfluß  
Bundesanstalt für Gewässerkunde  
Koblenz, Deutschland

Global Runoff Data Centre  
Federal Institute of Hydrology  
Koblenz, Germany

**Report No. 18**

**GRDC Status Report 1997**



**June 1998**

56068 Koblenz, Kaiserin-Augusta-Anlagen 15-17  
Phone +49-261-1306-5224, Fax +49-261-1306-5280  
email: [grdc@koblenz.bfg.bund400.de](mailto:grdc@koblenz.bfg.bund400.de)

## Annexes to the Report

Annex 1	Database update list 1997 .....	15
Annex 2	Available Data in the GRDC Database .....	24
Annex 3	Distribution of GRDC Stations (map) .....	25
Annex 4	Revised GRDC Policy Guidelines for the Dissemination of Data .....	26
Annex 5	Database requests 1997 .....	32
Annex 6	Transformation of measured runoff data to grid points .....	42
Annex 7	The development of a GIS-supported Water Balance Model as a Tool for the Validation of Climate Models and Hydrometeorological Datasets ..	43
Annex 8	Statistical evaluation of river discharge data .....	45
Annex 9	Commented Status of the Membership of the GRDC Steering Committee .	47
Annex 10	List of GRDC Reports .....	48
Annex 11	List of Acronyms .....	50

## Database development

In 1997, data were received for 237 stations. 85 stations were added as new stations in the database, while 151 of the already existing stations were updated. 17 countries have contributed data to the GRDC (see table 1 and annex 1 to this report).

Country	New	Updated	Total
Uruguay	6	2	8
United Kingdom	0	9	9
Russian Federation	1	24	25
Nepal	20	3	23
Greece	7	3	10
Israel	2	4	6
Hungary	0	17	17
Germany	1	10	11
Netherlands	0	1	1
USA	0	7	7
Italy	1	1	2
Ecuador	8	23	31
Guyana	0	6	6
Mekong Basin	0	32	32
Trinidad & Tobago	5	0	5
Australia	27	9	36
Slovenia	8	0	8
$\Sigma$	86	151	237

Table 1: Number of Stations, Update 1997

Over 50% of the newly included stations came from Australia and Nepal (a country mission to Nepal was performed in 1997). For the greatest part of the stations, time series could be obtained which reach into the early or mid 90's, so that the peak of the data shifted into more recent years. Annex 2, which displays the number of stations for every year, shows that the shift of data towards more recent years continued, but data providers must be requested to provide data in a more timely manner where this is possible in order to keep the database up to date. The peak of the time series lies around 1980, which is not so bad for historical time series - however, for many hydrological or climatological research purposes it would be useful to have more recent data, because of the overlapping with other datasets (e.g. remote sensing data), which are often only available for the last recent years. An institutionalized transfer of data from the providing countries to the GRDC is followed by a relatively small number of countries up to now.

The database now consists of 3658 stations, from which 2184 stations provide mean daily discharge data and 3232 stations provide mean monthly discharge data. An impression of the station locations worldwide and their spatial distribution gives annex 3 (world map). A complete station catalogue is available at the GRDC on request or can be downloaded directly from the Internet home page of the GRDC under the URL of <http://www.bafg.de/grdc.htm>. As an alternative download the ftp-server of the Federal Institute of Hydrology may be used: <ftp://anonymous@www.bafg.de/pub/grdc/cat>, where a zip-file with the 32-bit version of the database catalogue tool is ready to be downloaded.

## **Data acquisition activities**

On various occasions, GRDC reiterated its request for data provisions for the Centre. Country missions to Nepal and India as well as to Slovenia, the Mekong Secretariat, Russia and the Ukraine and other good contacts established in 1996 with countries of Latin America and the Caribbean resulted in a very satisfactory data acquisition in general, however, data deliveries from most African countries remain very low.

In general, one of the most important tasks for the near future will be to collect data for the major rivers of the world with a maximum of overlapping time series. Major difficulties in the collection of hydrological data are political constraints of many countries and the institutional capacity of the data-keeping organisations to provide data. In many cases, even the data of one country are often distributed over different institutions, depending on the administrative structure of the hydrological service of the country. In this respect, there is a growing importance of regional, multinational projects as FRIEND, WHYCOS or others for the global exchange of hydrological data and related information. Likewise, as the example of the Mekong Secretariat shows, close contacts to such basin- and regional institutions are gaining in importance.

## **Quality control**

As stated in the GRDC Policy Guidelines for the Dissemination of Data (annex 4), the providing agencies are responsible for the quality of the data. The import of raw data from the data providing agencies into the GRDC database includes an obligatory screening procedure of the data for obvious errors. Due to the time- and personnel-intensive testing procedures for in-depth quality control, the use of the GRDC Plausibility Software and other statistics-based software is applied only for specified projects and data sets within the GRDC.

In 1997, there were two datasets which were examined by a more detailed plausibility control. The first one was the dataset of 35 stations compiled for the Second Interim Report (Report No. 12) for the Arctic Climate System Study (ACSYS). This dataset was used for the calculation of river flows into the Arctic Ocean as a contribution to ACSYS. For a description of the correction method, please refer to GRDC report No. 15. Furthermore, a plausibility control was applied on the time series of the 160 stations near the mouth of major rivers used for the calculation of the freshwater fluxes into the world's oceans in GRDC report No. 10.

The time series of monthly and daily values were displayed as a graph on the screen and visually controlled. Any irregularities which could be located in this way were examined in the raw data and, if possible, corrected. A correction was only made when the correct value could be reconstructed without any doubt, for example if a wrong order of digits or a missing zero was detected. No data gaps were filled. In most cases the data correction could be applied using the method of linear interpolation or manual correction.

As a result, a very low error rate was found in the time series.



includes now also flow-duration curves, variability plots of discharge and distribution functions as well as basic statistics.

The Database Catalogue Tool, which is a user-friendly software for the query of the database contents, is now available in a 16-bit (Windows 3.x) and 32-bit (Windows '95/NT) version. With both versions, a newly developed search tool is delivered together with the catalogue information. Figure 1 is a screen-dump of the database catalogue software, where the different selection criteria in the upper part of the window can be seen as well as an example catalogue query in the viewer below.

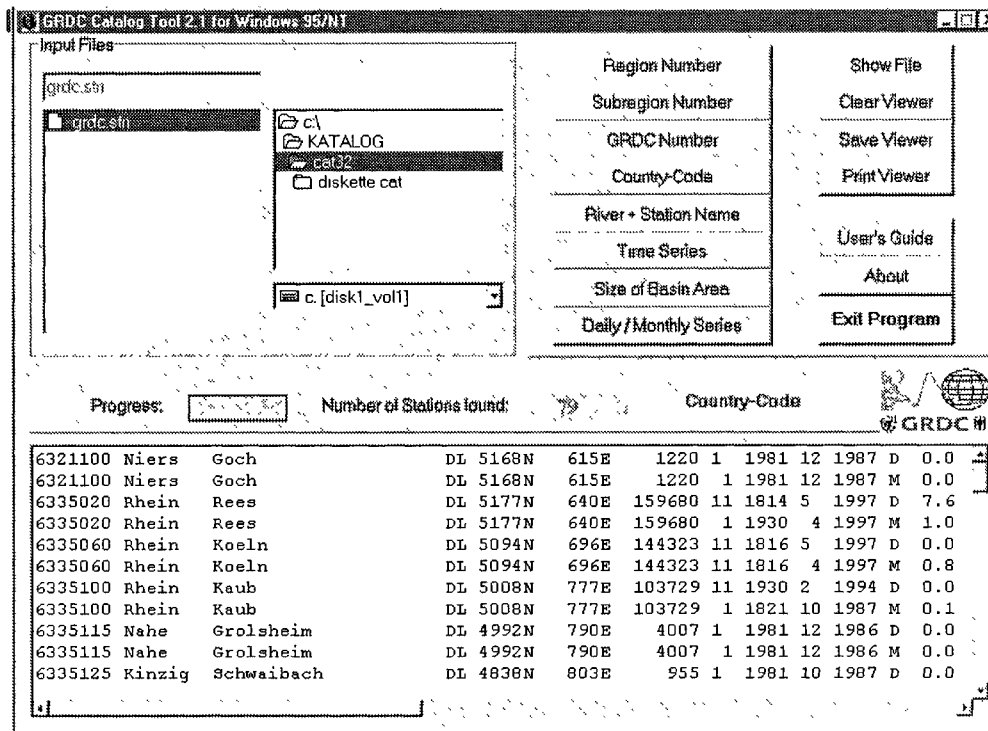


Figure 1: Screen-Dump of the Database Catalogue's main window

## Internet Homepage

With the installation of the web-server of the Federal Institute of Hydrology in 1997 the opportunity was given to set up a GRDC-homepage administered directly by GRDC/FIH. In August 1997, the GRDC homepage on the FIH-server became operational and has now (5/98) substituted the GRDC-pages on the Internet-server of the World Meteorological Organisation in Geneva. On the WMO server a link to the new homepage will remain, so that there will not be any changes for the user. As an advantage there will be a greater flexibility in operation and maintenance of the web page and a more timely access to updated catalogue information.

Since the page became operational in autumn 1997, 68 downloads of the GRDC database catalogue tool were registered until the end of the year 1997.

The new URL is: <http://www.bafg.de/grdc.htm>

A new ftp-server has been installed, where the GRDC database catalogue can be downloaded (32 bit version for Windows 95/NT) as a zipped file. The address is:

**ftp://anonymous@www.bafg.de/pub/grdc/cat**

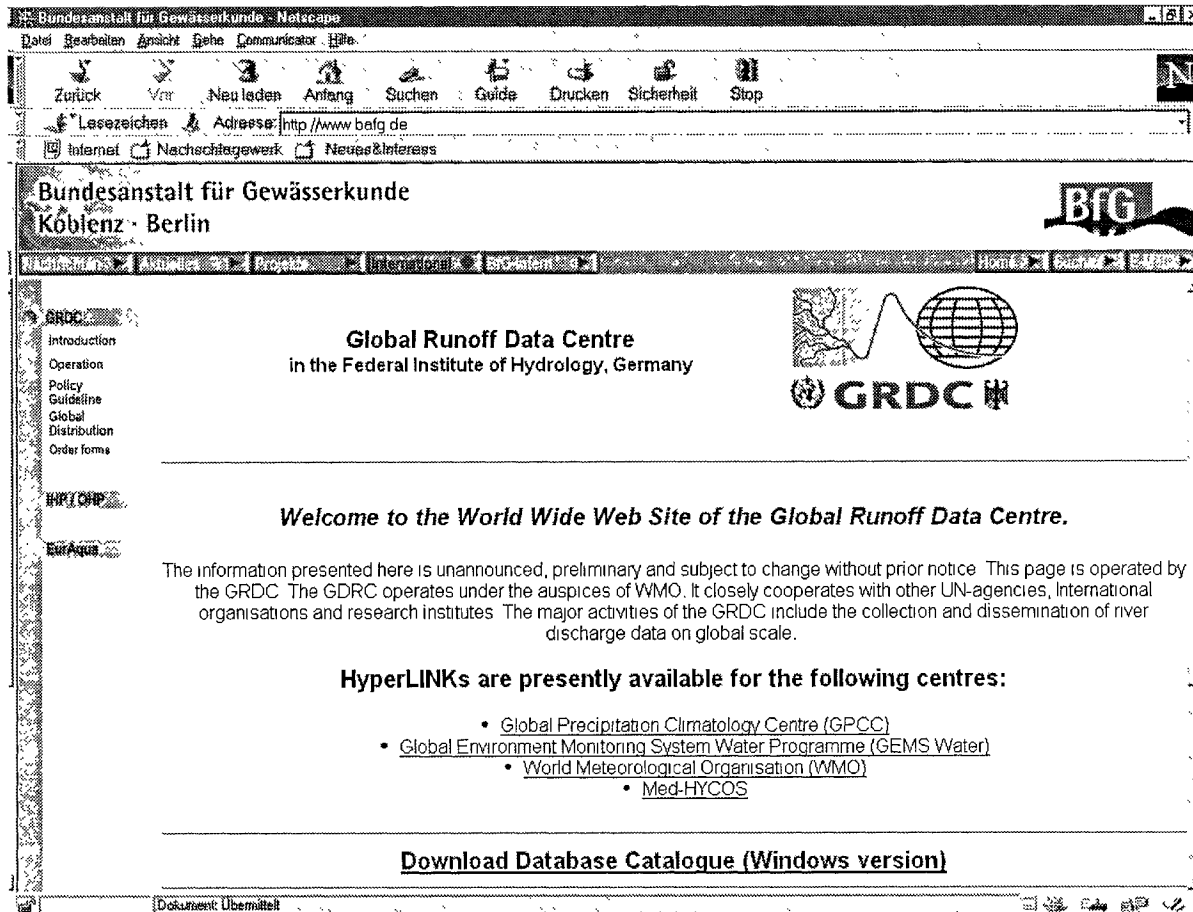


Figure 2: Screen-Dump of the frontpage of the GRDC-homepage (www.bafg.de/grdc.htm)

## GRDC Brochure

Based on the success of the English version of the brochure and on request by francophone and spanish-speaking countries, WMO has in 1997 provided to GRDC translations of the text. GRDC will publish the brochure in French and Spanish by the end of 1998.

## Research issues

As a contribution to the World Climate Programme Water (WCP-Water), the following three research projects are undertaken at the Federal Institute of Hydrology.











data including river discharge data. As data sources there are up to now 20 recently delivered data collection platforms with Meteosat-transmission capability as well as the already existing gauging stations.

In 1997, the collaboration between GRDC and Med-HYCOS was strengthened in the fields of database technology and data exchange. Med-HYCOS may become, together with the other regional HYCOS-projects, one of the most important providers of near-real time hydrological data. In 1997, GRDC took part in two meetings of Med-HYCOS - the meeting of the Initial Coordinating Group in Metkovic/Croatia and in the Meeting of the Regional Task Force 4 in Montpellier. Two scientists of ORSTOM, which is together with other agencies responsible for the implementation of Med-HYCOS, visited the GRDC. As a result, an agreement was set up about the collaboration and data exchange between GRDC and the Med-HYCOS regional data base. Furthermore, GRDC visited ORSTOM to intensify the collaboration in the field of database technology and data management.

GRDC expects to become actively involved in the SADC-HYCOS project which will be launched later in 1998.

## **UNESCO-FRIEND**

The UNESCO-FRIEND project from UNESCO (Flow Regimes from International and Experimental Network Data) is organised in several regional sub-projects. Although the focus for the data collection is on smaller catchments with a minimum of anthropogenic influence, there are some overlaps with GRDC data collection activities.

Data generated within the several FRIEND projects are restricted to members of the established FRIEND working groups and generally not accessible for others. Each regional FRIEND-project is responsible for its own data holding and for the possible access to the data. An example for this is FRIEND Northern Europe. GRDC has attained the role as data manager for Germany, Switzerland and Austria. The cooperation between GRDC and FRIEND is accentuated inter alia by the participation and involvement of GRDC and FRIEND in its respective Steering Committees and informal consultations.

From the viewpoint of GRDC, there is a need to establish a framework for data exchange between regional FRIEND projects and GRDC. In any case, FRIEND data which are published in yearbooks or published in electronic format should be made accessible to GRDC.

For the recently established FRIEND-project for the Hindu Kush Himalaya region (HKH-FRIEND), GRDC has responsibilities for the implementation of the regional database. The HKH-FRIEND is the first one where WMO/GRDC is directly involved together with UNESCO with the generous assistance of the German National IHP/OHP Committee.

## **GTOS / GCOS**

The main objective of GTOS, the Global Terrestrial Observing System, as given in the GTOS





The Netherlands

- Gesellschaft für technische Zusammenarbeit, Eschborn, Germany
- Centro Interamericano de Desarrollo e Investigación Ambiental y Territorial, Mérida, Venezuela
- ORSTOM (L'Institut français de recherche scientifique pour le développement en coopération), France.

## **New GRDC Reports**

In 1997, the following five reports have been published.

Report No. 13 (February 1997) is the GRDC Status Report 1996. For the future (starting 1998), GRDC intends to change the yearly rhythm for the Status report into a two-year rhythm, combined with the sessions of the Steering Committee. Interim news will be made available on the GRDC web site.

Report No. 14 (February 1997): The use of GRDC-information, Review of data use 1993/94 - Status January 1997. This report contains abstracts of research projects which have been undertaken by using data of the GRDC. 56 % of all users did answer to a questionnaire requesting information about their project. The lagtime of 2-3 years between the original request and this report was chosen because the typical duration of a research project is 2-3 years.

Report No. 15 (June 1997): Third Interim Report on the Arctic River Database (ARDB) for the Arctic Climate System Study (ACSYS): Plausibility Control and Data Corrections (Technical Report). This short report includes a description of methods and results of the plausibility control applied on the set of 35 ACSYS-stations which were used for the calculation of the river runoff into the Arctic Ocean.

Report No. 16 (August 1997): The GRDC database. Concept and Implementation. This report contains a detailed description of the database technology as well as of the dataflow, import/export routines, administrative tools and corresponding evaluation software used in the GRDC.

Report No. 17 (September 1997): Report on the Third Meeting of the GRDC Steering Committee, Koblenz, Germany, June 25-27, 1997.

For a recent list of GRDC-reports, see annex 10.









Country	Date	GRDC-No.	River	Station	from-to	Daily Monthly	New Update
	17.11.1997	3308400	Cuyuna	Kamaria Falls	1987	D	U
	17.11.1997	3308600	Essequibo	Plantain Island	1991-1995	D	U
	17.11.1997	3309300	Demerara	Great Falls	1991-1995	D	U
	17.11.1997	3309700	Canje	Reynold's Bridge	1987-1995	D	U
Hungary	04.02.1997	6442050	Raba	Szentgotthard	1992-1995	D/M	U
	04.02.1997	6442200	Marcal	Rabaszentmiklos	1990-1995	D/M	U
	04.02.1997	6442300	Kapos	Kurd	1992-1995	D/M	U
	04.02.1997	6442450	Danube	Dunaalmas	1992-1995	D/M	U
	04.02.1997	6442500	Danube	Nagymaros	1992-1995	D/M	U
	04.02.1997	6442600	Danube	Mohacs	1992-1995	D/M	U
	04.02.1997	6444090	Tisza	Tiszabecs	1991-1995	D/M	U
	04.02.1997	6444100	Tisza	Szeged	1992-1995	D/M	U
	04.02.1997	6444110	Maros	Mako	1992-1995	D/M	U
	04.02.1997	6444200	Tisza	Szolnok	1992-1995	D/M	U
	04.02.1997	6444250	Zagyva	Jasztelek	1992-1995	D/M	U
	04.02.1997	6444310	Tisza	Tiszapalkonya	1992-1995	D/M	U
	04.02.1997	6444350	Bodva	Szendro	1992-1995	D/M	U
	04.02.1997	6444380	Sajo	Felsozsolca	1992-1995	D/M	U
	04.02.1997	6444400	Fehér-Koros	Gyula	1992-1995	D/M	U
	04.02.1997	6444500	Kraszna	Agerdomajor	1992-1995	D/M	U
	04.02.1997	6444600	Szamos	Csenger	1992-1995	D/M	U
Israel	29.01.1997	6593700	Soreq	Near Gedera	1960-1992	D	U
	29.01.1997	6593500	Alexander	Alyashiv	1967-1993	D	U
	29.01.1997	6593800	Be'er Sheva	Near Hatserim	1988-1993	D	U
	29.01.1997	6594050	Jordan	Obstacle Bridge	1988-1993	D	U
	29.01.1997	6594070	Jordan	Sede Nehemya	1984-1992	D	N
	29.01.1997	6594080	Jordan	Naharyim	1988-1993	D	N
Italy	10.11.1997	6349200	Adige	Bronzolo	1975-1990	D/M	U
	10.11.1997	6349300	Adige	Trento	1955-1981	D/M	N































## Cost of GRDC Services

1. Staff time is based on a per hour rate which in June 1997 was set at DM 75,--. This includes all overheads and mail services.
2. To give an indication of the approximate costs of databank services, the following can serve as a guide:
  - a) Simple queries, such as a search for all stations of three major rivers and the extraction of mean daily discharge data:

Estimated time for completion: 1.5 hours  
Approximate cost (June 1997) : DM 112,50
  - b) Complex queries, such as the selection of daily discharge time series of at least 20 years for 20 stations from three major rivers, with maximum overlap of time series:

Estimated time for completion: 5 hours  
Approximate cost (June 1997) : DM 375,--
3. For complex tasks where data products (statistical evaluations, graphics, etc.) are also requested, a cost estimate is made and agreed upon in advance.
4. Services for projects which require extensive work at the GRDC or the establishment of an own database are agreed upon in a Memorandum of Understanding (MoU) between the project partners. In these cases, the financial contribution for the services of the GRDC are costed and incorporated in the MoU.
5. Payment for services is by bank transfer to the credit of the GRDC:

**BUNDESKASSE KOBLENZ, LANDESZENTRALBANK KOBLENZ  
BLZ: 570 000 00, ACCOUNT: 570 010 01, credit: 1203/11902 GRDC**

Cheques sent by registered mail and made payable to "GRDC" are also acceptable.





Request made by (Name, country)	Country or river for which data were requested	Purpose of data use
Dr. Isabelle Niang-Diop, Département de Géologie, Université Cheik Anta Diop, Dakar-Fann, Senegal	-----	Request for general support in the preparation of a database for the coastal zone of Senegal
Jay Famiglietti, Dept. of Geological Sciences, University of Texas, Austin, USA	GRDC report No. 10	Possible incorporation of GRDC data in an oceanic global climate model
Jane Foster, Dept. of Geology and Geophysics, Yale University, New Haven, USA	9 rivers of Southwest Asia	Investigation exploring climate variation and the effect on agricultural production in Southwest Asia
Christian France-Lanord, Dept. of Geological Sciences, Cornell University, Ithaca, USA	GRDC Reports No. 5 and 10	General scientific interest
Paul Ganahl, Hydrographische Abteilung der Verbund-Elektrizitäts- werke Kaprun	Discharge data of the Spanish Rivers Tortoza and Zaragoza	Examination of possible climatic changes in the Ebro basin
Philippe Gauzelin, Space Oceanography Departement, CLS, Toulouse, France	Mediterranean Region (general information about data availability, request pending)	PhD thesis about the water and heat flux budget of the Mediterranean Sea
Pieter van Gelder, Delft University of Technology, The Netherlands	Discharge data of stations in the Oder catchment (database catalogue)	Frequency analysis of extreme values (maxima)
Christian Gerbich, Inst. für Biogeochemie und Meereschemie, Hamburg, Germany	Several rivers in the tropical and subtropical region of Asia	Modelling transport mechanisms of solid and dissolved matters in oceans and rivers
Marc Gordon, Centre for Arid Zone Studies, UK University of Cambridge	Historical streamflow data for the Benue River Basin (catalogue)	MSc Dissertation in Water Resources

<b>Request made by (Name, country)</b>	<b>Country or river for which data were requested</b>	<b>Purpose of data use</b>
Steve Graham, Dept. of Geological Sciences, University of Texas, Austin, USA	Report No. 10, 5, 12, 14	General scientific purposes
Dr. Alan Hall, Australia	GRDC catalogue for Australia	General reference purposes
G. Hartmann, Institut für Wasserbau, Universität Stuttgart	GRDC database catalogue	General information about the availability of discharge data in Africa and the Middle East
Martin Hollingham, University of Wales, Bangor, UK	GRDC report No. 5 and No. 10, Status Report 1996	General research work and educational purposes
Kaisa Hietala, Scott Polar Research Institute, University of Cambridge, U.S.A	35 ACSYS-stations	PhD thesis: Fresh water variation on the Arctic Ocean
Noboyuki Imanishi, Shinko Research Ltd., Tokyo, Japan (research company of Kobel Steel Ltd.)	GRDC database catalogue	Global Potential of hydrogen gas production by hydropower (no transfer of raw data - commercial use)
S.R. Jones, Engineering Consultant, The Harroway, Whitchurch, UK	Data of the Casamance River, Senegal (data not available at GRDC)	Undersea fiber optics cable project South America - Africa
Shinya Kakuta, Ocean Research Department, Japan marine science and technology center, Yokosuka, Japan	Data of the Yukon River	Model study within ACSYS (Arctic Climate System Study)
Frank Kaspar, Wissenschaftl. Zentrum für Ökosystemforschung, Universität Kassel, Germany	43 stations from South America	Global modelling of consumption, availability of water and prognosis
Prof. Kempe, Geologisch-Paläontologisches Institut, Technische Universität Darmstadt, Germany	Database catalogue of Argentina (request pending)	EU-research project: biogeochemistry of Argentinian Rivers











<b>Request made by (Name, country)</b>	<b>Country or river for which data were requested</b>	<b>Purpose of data use</b>
Cord Ruhe, International Baltex Secretariat, GKSS Forschungszentrum Geesthacht, Deutschland	7 river discharge stations from Russia and Finnland	Examination of river runoff processes in the Baltex-area
K. Schulte, University of Colorado, Boulder	Database catalogue of Albania	General information about the availability of discharge data of Albania
Bernd Schwan, IUS GmbH, Heidelberg, Germany	3 rivers from Poland	Environmental Impact Assessment for the German Waterways and Shipping Administration
Bernd Schwan, IUS GmbH, Heidelberg, Germany	9 stations from the Oder	Environmental Impact Assessment for the German Waterways and Shipping Administration
Prof. Igor Shiklomanov, Russia State Hydrological Institute, St. Petersburg, Russia	3 stations from Rhein, Weser, Elbe	Analysis of changes of river runoff of the Northern Hemisphere in different time periods
Dr. Laurence C. Smith, University of California, Los Angeles, Dept. of Geography, USA	GRDC Report No. 12	General information
Alejandro Spitzzy, Institut für Biogeochemie und Meereschemie, Universität Hamburg, Germany	Database catalogue extract for Malaysia	General information about availability of gauging stations in Malaysia
Ronald E. Stewart, Climate Processes and Earth Observation Division, Atmospheric Environment Service, Canada	General information about GRDC	Presentation of GRDC in meeting of GEWEX Hydrological Panel (GHP)
Dr. Kevin Telmer, Geological Survey of Canada	General information about the availability of GRDC data	Research projects about the biogeochemistry of rivers



## Transformation of Measured Runoff Data to Grid Points

Karlheinz Daamen

Within the framework of a national research project funded by the Federal Ministry of Education and Research (BMBF), methods for the calculation of grid-based runoff on a  $0.5^\circ \times 0.5^\circ$  grid were extended and verified for the Weser and Elbe catchments. Simultaneously, the project contributed also to the WMO WCP- Project B.3: Development of Grid-related Estimates of Hydrological Variables. Only the area-weighted runoff balancing (method 1) enables to calculate the grid-based runoff exclusively from gauge-based runoff data, although it is only applicable to areas with a high gauging station density. Data acquisition and assimilation, as well as the digitization of gauge-bases catchment limits are highly time-consuming. This method, therefore, may only be used for selected regions for which it may serve as a reference data set for the evaluation of the quality of the other methods, too.

The disaggregation of runoff by the use of statistical relationships between runoff and catchment characteristics (method 2) needs, at least at topographically more intensively structured relief, the inclusion of long-term mean areal distribution of precipitation depth. By this procedure, empirical relationships between runoff and precipitation as well as further catchment characteristics can be established. The relationships are regionally differentiated. The influence of evapotranspiration on runoff is not explicitly taken into consideration within the computational scheme. Therefore, this method was not further investigated within the project.

With respect to a possible continent-wide applicability, the water balance model of Thornthwaite-Mather was extended. The model WABIMON enables the calculation of long-term mean grid based runoff using the existing global hydrometeorological and physiographic data sets. Combined with the monthly means of runoff at selected reference gauges, the time-dependent grid-based runoff can be calculated.

Improvements in future projects have to be done in the model components of the water balance model, especially the parameterization of runoff coefficient, and in the selection criteria of the reference gauges. For this task, the runoff data of the Global Runoff Data Centre (GRDC) and the precipitation data (Rudolf et al., 1992) of the Global Precipitation and Climatology Centre (GPCC) of Europe are foreseen for evaluation. Method 3 forms the basis for the calculation of timely monthly overviews of grid-based runoff planned by the GRDC.

The project has finished at the end of 1995. The results have been documented in a report (BfG, 1997).

### References

BfG (1997): Übertragung von gemessenen Abflußwerten auf Gitterpunkte, BFG-1062, Koblenz.

Rudolf, B., Hauschild, H., Reiss, M. & Schneider, U. (1992): Die Berechnung der Gebietsniederschläge im  $2,5^\circ$ -Raster durch ein objektives Analyseverfahren. *Meteorologische Zeitschrift* **1**, S. 32-50.



infiltration excess runoff will be improved using an extended precipitation climatology and a probability-distributed soil moisture storage.

In further studies a validation and verification of the Water Balance Model is planned for the whole territory of Europe using the discharge data stored in the GRDC and precipitation datasets of GPCC.

#### Literature

BfG (1997): Übertragung von gemessenen Abflußwerten auf Gitterpunkte, BfG-1062, Koblenz

Krahe P. and W. Grabs (1996): The Development of a GIS-supported Water Balance Model as a Tool for the validation of Climated Models and Hydrometeorological Datasets. WMO/IAHS Workshop on Continental Scale Hydrological Models: Charting the Future, 11-13 November 1996, Wallingford

Krahe P., K-H. Daamen, R. Mülders and K. Wilke (1997): GIS-related baseflow simulation for water balance and precipitation-runoff modeling in the River Rhine basin. IAHS Publication no. 242

Thornthwaite, C.W. and J.R. Mather (1957): Instructions and tables for computing potential evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, 10, (3), Centeron, New Jersey

Vörösmarty C.J., B. Moore III, A.L. Grace, et al. (1989): Continental Scale Models of Water Balance and Fluvial Transport: An Application to South America. Global Biogeochemical Cycles, Vol. 3, No. 3, 241-265









## Reference of GRDC Reports

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- Report No. 1**      Second Workshop on the Global Runoff Data Centre, Koblenz, Germany, 15 - 17 June, 1992.  
(May 1993)
- Report No. 2**      Dokumentation bestehender Algorithmen zur Übertragung von Abflußwerten auf Gitternetze. (Incl. abstract in English by the GRDC: Documentation of existing algorithms for transformation of runoff data to grid cells) by G.C. Wollenweber.  
(May 1993)
- Report No. 3**      GRDC - Status Report 1992.  
(June 1993)
- Report No. 4**      GRDC - Status Report 1993.  
(June 1994)
- Report No. 5**      Hydrological Regimes of the Largest Rivers in the World -  
(November 1994) A Compilation of the GRDC Database.
- Report No. 6      Report of the First Meeting of the GRDC Steering Committee,  
(December 1994) Koblenz, Germany, June 20 - 21, 1994.
- Report No. 7**      GRDC - Status Report 1994.  
(June 1995)
- Report No. 8**      First Interim Report on the Arctic River Database for the  
(July 1995) Arctic Climate System Study (ACSYS).
- Report No. 9**      Report of the Second Meeting of the GRDC Steering Committee,  
(August 1995) Koblenz, Germany, June 27 - 28.
- Report No. 10**      Freshwater Fluxes from Continents into the World Oceans based on  
(March 1996) Data of the Global Runoff Data Base.
- Report No. 11**      GRDC - Status Report 1995.  
(April 1996)
- Report No. 12**      Second Interim Report on the Arctic River Database for the  
(June 1996) Arctic Climate System Study (ACSYS).
- Report No. 13**      GRDC Status Report 1996  
(Februray 1997)



